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FLORISTICS OF FOUR SMALL BOGS IN WESTERN LOUISIANA WITH OBSERVATIONS ON SPECIES/AREA RELATIONSHIPS

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ABSTRACT

A floristic inventory of four small bogs (0.03-0.07 ha.) in the Kisatchie National Forest, Louisiana, has been done so as to compare their species richness with that of seven other larger bogs (0.4-3.0 ha.) in the same area. The smaller bogs had between 63 and 71 species per bog; the larger ones ranged from 92 to 105 species per bog. For the total sample of eleven bogs there is a clear species/area relationship in which smaller bogs have significantly fewer species. The phytogeographic implications of this are discussed.

KEY WORDS: Kisatchie National Forest, bog, island biogeography, floristics, species/area relationship, species richness

INTRODUCTION

In three previous papers we have described the floristics and soil conditions of seven hillside seepage bogs in western Louisiana (MacRoberts & MacRoberts 1988, 1990, 1991). In this paper we describe the floristic composition and soil conditions of four small hillside seepage bogs. Additionally, we compare the species/area relationship of all the bogs we have studied. The rationale for this is contained in any discussion of island biogeography in which species richness is the focus. Bogs are "habitat islands" isolated by intervening habitat of another type. For such "islands," a balance is predicted to occur between immigration and extinction that is a function of size and degree of isolation. Smaller islands have fewer species than larger islands because they are "ecologically poorer" and because extinction is higher due to the greater vulnerability of small populations. Also, the greater the degree of isolation, the fewer the number of species because of greater problems in initial colonization or recolonization after extinction (see Case & Cody 1987; Begon *et al.* 1990; Diamond & May 1976; Lack 1976; Williamson 1981, 1988).

Table 1. Soil Characteristics.

		Exchangable Ions (ppm)				
Site	pH	P	K	Ca	Mg	OM%
RCW	5.3	19	27	450	83	2.7
Robin	4.9	8	39	440	182	3.5
Vine	5.3	3	37	290	105	3.7
Sparrow	4.9	4	37	150	61	2.5

STUDY SITES/METHODS

Vine, Robin, Sparrow, and RCW bogs are located in the Kisatchie Ranger District, Kisatchie National Forest, Natchitoches Parish, Louisiana. They are located approximately 5 km east, 8.5 km northeast, 5 km northeast, and 15 km southeast of Lotus, Louisiana, and measure 0.07, 0.03, 0.04, and 0.03 ha., respectively. They are between 70 and 100 meters above sea level. All four are open with little or no canopy or midstory and are surrounded by longleaf pine woodland (Martin & Smith 1991). They occur on hillsides on slopes varying between 5 and 20 degrees. All have *Sphagnum* moss but it is not dominant in any. They occur on Kisatchie clay and Kisatchie-Oula soils (see Martin *et al.* 1990) that are saturated throughout the year. The climate is described in our previous papers and in Martin *et al.* (1990); however, 1991 was one of the wettest years in recorded history, with about 170 cm of precipitation. These four bogs are in good condition. None was burned the year previous to the study.

We visited all four bogs every other week from March to November 1991. Voucher specimens for many of the species were collected. Rare or easily identified plants were not collected. We follow MacRoberts (1984, 1989) for most scientific nomenclature. Soil samples were taken from the upper 15 cm of each bog and were analyzed by A & L Laboratories, Memphis, Tennessee.

RESULTS/DISCUSSION

In Table 1 we give soil information for the four bogs. Soils are similar among them and to the soils of the seven bogs we studied previously.

In Table 2 we list the species found in the four bogs. "V" indicates presence at Vine Bog, "R" at Robin Bog, "S" at Sparrow Bog, and "RCW" at RCW Bog. No letter indicates presence at all four bogs.

We recorded 95 taxa for these four bogs, representing 63 genera and 36 families. Vine bog had 71 taxa, Robin Bog had 63 taxa, Sparrow Bog had 64 taxa, and RCW Bog had 69 taxa. These four bogs are floristically similar.

Table 2. Taxa present.

DENNSTAEDTIACEAE — *Pteridium aquilinum* (L.) Kuhn, (V,S,R).
LYCOPODIACEAE — *Lycopodium alopecuroides* L.; *L. appressum* (Chapm.) Lloyd & Underw., (RCW); *L. carolinianum* L.
OSMUNDACEAE — *Osmunda cinnamomea* L., (V,R); *O. regalis* L., (V).
PINACEAE — *Pinus palustris* P. Mill.; *P. taeda* L., (RCW,S,R).
AMARYLLIDACEAE — *Hypoxis rigida* Chapm.
BURMANNIACEAE — *Burmannia capitata* (Walt.) Mart.
CYPERACEAE — *Eleocharis tortilis* (Link) Roem. & Schult., (RCW); *Fuirena squarrosa* Michx., (V,R); *Rhynchospora chalarocephala* Fern. & Gale, (R); *R. globularis* (Chapm.) Small var. *globularis*, (RCW,S,R); *R. gracilenta* A. Gray; *R. macra* (C.B. Clark) Small, (RCW,V); *R. oligantha* A. Gray, (RCW,V,S); *R. plumosa* Ell.; *R. pusilla* Chapm. *ex* M.A. Curtis, (R); *Scleria ciliata* Michx., (V,S); *S. georgiana* Core, (RCW); *S. reticularis* Michx.
ERIOCAULACEAE — *Eriocaulon decangulare* L.; *Lachnocaulon anceps* (Walt.) Morong., (RCW,V,S).
JUNCACEAE — *Juncus marginatus* Rostk., (R); *J. scirpoides* Lam., (RCW,V); *J. trigonocarpus* Steud., (RCW,V,R).
LILIACEAE — *Aletris aurea* Walt.; *Smilax laurifolia* L.
ORCHIDACEAE — *Calopogon tuberosus* (L.) B.S.P.; *Pogonia ophioglossoides* (L.) Juss.
POACEAE — *Andropogon ternarius* Michx.; *Aristida virgata* Trin.; *Dicanthelium acuminatum* (Sw.) Gould & Clark; *Eragrostis spectabilis* (Pursh) Steud., (V,S); *Gymnopogon brevifolius* Trin., (RCW,R); *Muhlenbergia expansa* (Poir.) Trin., (RCW,V); *Panicum virgatum* L.; *Paspalum floridanum* Michx., (RCW,S,R); *Schizachyrium scoparium* (Michx.) Nash; *S. tenerum* Nees, (RCW,V,S); *Tridens ambiguus* (Ell.) Schultes, (RCW,V).
XYRIDACEAE — *Xyris ambigua* Bey. *ex* Kunth; *X. baldwiniana* Schultes, *X. difformis* Chapm. var. *curtissii* (Malme) Kral; *X. drummondii* Malme, (V); *X. scabrifolia* Harper, (V,R); *X. torta* Smith, (RCW,S).
ACERACEAE — *Acer rubrum* L.
ANACARDIACEAE — *Toxicodendron radicans* (L.) Kuntze, (V,R); *T. vernix* (L.) Kuntze.
APIACEAE — *Eryngium integrifolium* Walt.; *Oxypolis rigidior* (L.) Raf., (R); *Ptilimnium capillaceum* (Michx.) Raf., (V).
AQUIFOLIACEAE — *Ilex coriacea* (Pursh) Chapm., (V,R); *I. opaca* Ait., (R); *I. vomitoria* Ait.
ASTERACEAE — *Aster dumosus* L.; *Coreopsis linifolia* Nutt.; *Eupatorium leucolepis* (DC.) Torrey & Gray; *E. rotundifolium* L.; *Helianthus angustifolius* L.; *Liatris pycnostachya* Michx.; *Marshallia graminifolia* ssp. *tenuifolia* (Raf.) Watson, (V); *Senecio tomentosus* Michx., (RCW,S,R).

CAMPANULACEAE — *Lobelia reverchonii* B.L. Turner.
CAPRIFOLIACEAE — *Viburnum nudum* L., (V).
CLUSIACEAE — *Hypericum brachyphyllum* (Spach.) Steud.; *H. crux-andreae* (L.) Crantz, (RCW,V); *H. hypericoides* (L.) Crantz, (RCW).
DROSERACEAE — *Drosera brevifolia* Pursh, (S,R); *D. capillaris* Poir.
ERICACEAE — *Rhododendron canescens* (Michx.) Sw., (R.); *Vaccinium corymbosum* L.
GENTIANACEAE — *Sabatia gentianoides* Ell.
LAURACEAE — *Persea borbonia* (L.) Spreng., (V,S).
LENTIBULARIACEAE — *Pinguicula pumila* Michx., (RCW,S), *Utricularia cornuta* Michx., (RCW,V,S); *U. juncea* Vahl. (V,S,R); *U. subulata* L.
LINACEAE — *Linum medium* (Planch.) Britt., (RCW,S).
LOGANIACEAE — *Cynoctonum sessilifolium* (Walt.) St. Hil.; *Gelsemium sempervirens* (L.) St. Hil.
MAGNOLIACEAE — *Magnolia virginiana* L.
MELASTOMATACEAE — *Rhexia mariana* L., (RCW,S); *R. petiolata* Walt., (RCW,V,S).
MYRICACEAE — *Myrica cerifera* L.; *M. heterophylla* Raf.
NYSSACEAE — *Nyssa sylvatica* Marsh.
POLYGALACEAE — *Polygala incarnata* L., (RCW).
SARRACENIACEAE — *Sarracenia alata* Wood, (V).
SCROPHULARIACEAE — *Agalinus obtusifolia* Raf., (RCW); *Gratiola neglecta* Torrey, (S); *G. pilosa* Michx., (S).
VIOLACEAE — *Viola primulifolia* L., (V).

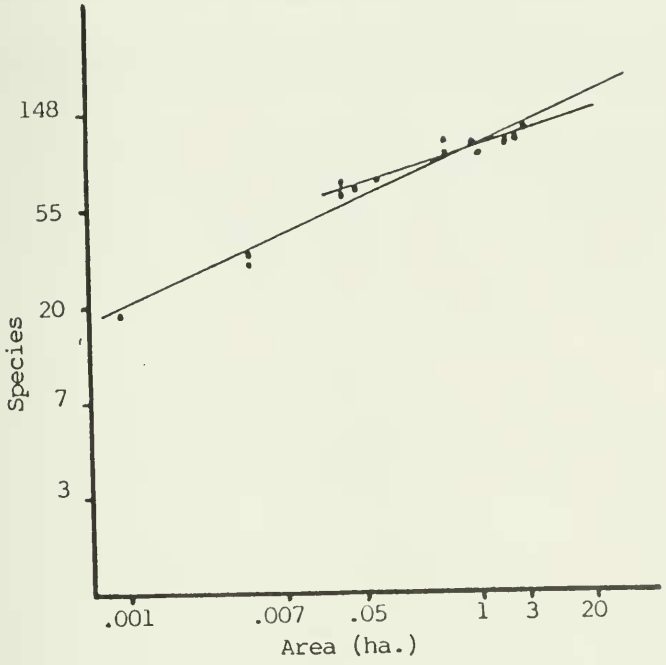

Figure 1. Species-area relationship.

Sorensen's Index of Similarity ranges from 74 to 81 among them. It ranges from 56 to 72 between them and the seven bogs we previously studied, the main reason for the difference being that the four small bogs had fewer species than the seven larger bogs.

In Figure 1 we show the species/area relationship for all eleven bogs. The seven previously studied bogs ranged from 0.4 to 3.0 ha. and had from 92 to 105 taxa. This year's bogs ranged from 0.03 to 0.07 ha. and had from 63 to 71 species. In Figure 1 are included also twelve measures that we made in 1990 on species richness in Frog Arrow and 360A Bogs (MacRoberts & MacRoberts 1991). These measures consisted of ten permanent one meter square plots (averaged in Figure 1) and two permanent twenty-five meter square plots. These data are shown to the left in the figure.

We have calculated the correlation coefficient between bog size and species richness in two ways. The first includes bogs and plots ($r = 0.97$). The other includes only bogs ($r = 0.93$). Clearly there is a strong positive relationship between bog size and number of species present. We have also calculated two species/area regression slopes. One includes plots and bogs ($z = 0.17$); the other includes only bogs ($z = 0.11$). Interestingly, these values are identical with those calculated by Williamson (1988:113) using Dony's data for open

habitats, such as bogs, in England. These habitats appear to have the lowest z values of any vascular plant community and are much lower than for other organisms.

What factors determine how many species exist in a particular bog? Is it simply a matter of size or is the answer more complex? We will make some comments but like most who have considered the species/area problem, we are unable to provide definitive answers; in fact, the whole of biogeography appears to be in a state of transition: no theory handles much data comfortably. Further, the analogy between our work on bogs and classical island biogeography must break down because there is no "mainland," only an archipelago of bogs — unless the large bogs of the gulf coastal plain, that is, northwest Florida, south Alabama, south Mississippi, and southeastern Louisiana, are to be considered the mainland. If this is entertained, then far too little is known about the mainland to make comparisons with the "islands" profitable. But our intention is not to press the analogy, but to use it insofar as it aids understanding.

Of the eleven bogs we have studied, ten are in the Kisatchie Ranger District. These ten are within about 13 km of each other and there are many other bogs scattered through the area. Strange Road Bog is in the Winn Ranger District, 55 km to the northeast (MacRoberts & MacRoberts 1988) and is not joined to the others by intervening bogs but is separated by the Red River and its flood plain. Also, there are no other bogs in the vicinity of Strange Road Bog: bog habitat appears to have been extremely limited in this part of Louisiana (Martin & Smith 1991) and is even more uncommon today. Nevertheless, although isolated, this bog is not floristically distinct from the others we have studied. It has the expected number of species, and there is nothing unusual about the species present as measured by Sorensen's Index of Similarity. This finding would suggest, at least for this instance, that isolation is not an important factor. Apparently, species in this habitat persist over long periods with little or no extinction, a finding made by others (*e.g.*, Jehl 1984).

Figure 1 can be interpreted in two ways. First, as the area of a bog increases, it gains species. Second, after reaching about one hectare, bogs do not gain additional species. Our data do not distinguish between these possibilities. Of 144 bogs in the Kisatchie Ranger District and on adjacent private land that we have surveyed, the largest is about 4.0 ha., the average is about 0.9 ha., and the modal is about 0.4 ha. Thus, we have floristic surveys over the range. Much larger bogs occur in the Vernon Ranger District about 50 km south of our study area, and, although there are no floristic surveys of these bogs, they appear to be floristically richer than those in our survey since they represent the northern limit for a number of species.

It has become obvious to us in the course of our work on bogs that bogs are not uniform habitat. They are patchy, and the larger the bog the greater

the number of microhabitats. For example, some areas in a typical bog are relatively "dry" with exposed sand while others are deep organic muck, and the two areas often support very different species. Smaller bogs are more homogeneous and consequently are less rich.

Clearly, while bogs fit the species/area relationship predicted by theory, the reasons they do so are not entirely clear. This is not a particularly surprising conclusion in light of the conflicting results obtained by numerous biogeographers over the past three decades. As Case & Cody (1987) comment, not one but many models may be required to explain patterns of species richness.

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APPENDIX

We take this opportunity to correct taxonomic mistakes in our previous papers. All *Paspalum laeve* Michx. should be *P. floridanum* Michx. *Schizachyrium scoparium* (Michx.) Nash reported for Woodcock Bog should be *S. tenerum* Nees. *Andropogon gerardii* Vitman should be *Schizachyrium scoparium* (Michx.) Nash. *Xyris drummondii* Malme does not occur in Frog Arrow Bog or 360A Bog. *Hedyotis uniflora* (L.) Lam. should be *Diodia virginiana* L. All *Hypericum fasciculatum* Lam. are *H. brachyphyllum* (Spach.) Stud. All reported *Aster ericoides* L. are *A. dumosus* L. *Aster dumosus* should be added to the species occurring at Woodcock Bog. *Xyris jupicai* L.C. Rich occurs at Strange Road Bog.

LITERATURE CITED

Begon, M., J.L. Harper, & C.C. Townsend. 1990. *Ecology: Individuals, Populations and Communities.* Blackwell Scientific Publications, Oxford, United Kingdom.

Case, T.J. & M.L. Cody. 1987. Testing theories of island biogeography. Amer. Sci. 75:402-411.

Diamond, J.M. & R.M. May. 1976. Island biogeography and the design of nature reserves. In: *Theoretical Ecology.* Ed. R.M. May. W.B. Saunders Co., Philadelphia, Pennsylvania. Pp. 163-186.

Jehl, J.R. 1984. Comings and goings on a desert isle. Natural History 93(2):6-11.

Lack, D. 1976. *Island Biology.* Univ. Calif. Press, Berkeley, California.

Martin, D.L. & L.M. Smith. 1991. A survey and description of the natural plant communities of the Kisatchie National Forest, Winn and Kisatchie Districts. Unpublished report, Louisiana Natural Heritage Program, Department of Wildlife and Fisheries, Baton Rouge, Louisiana.

Martin, P.G., C.L. Butler, E. Scott, J.E. Lyles, M. Mariano, J. Ragus, P. Mason, & L. Schoelerman. 1990. Soil survey of Natchitoches Parish, Louisiana. United States Department of Agriculture, Soil Conservation Service, Washington, D.C.

MacRoberts, B.R. & M.H. MacRoberts. 1988. Floristic composition of two west Louisiana pitcher plant bogs. Phytologia 65:184-190.

MacRoberts, B.R. & M.H. MacRoberts. 1990. Vascular flora of two west Louisiana pitcher plant bogs. Phytologia 68:271-275.

MacRoberts, B.R. & M.H. MacRoberts. 1991. Floristics of three bogs in western Louisiana. Phytologia 70:135-141.

MacRoberts, D.T. 1984. *The Vascular Plants of Louisiana.* Bull. Museum Life Sciences, No. 6, Louisiana State University-Shreveport, Louisiana.

MacRoberts, D.T. 1989. *A Documented Checklist and Atlas of the Vascular Flora of Louisiana.* Bull. Museum Life Sciences, Nos. 7-9, Louisiana State University-Shreveport, Louisiana.

Williamson, M. 1981. *Island Populations.* Oxford University Press, Oxford, United Kingdom.

Williamson, M. 1988. Relationship of species number to area, distance and other variables. In: *Analytical Biogeography.* Ed. A.A. Myers & P.S. Giller. Chapman and Hall, London, United Kingdom. Pp. 91-115.